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ABSTRACT

Described is a project in which microcomputers were used by seven teachers in grades 2-6 in Edmonton, Alberta. The microcomputer was placed in each classroom for one-half day every day for a full school year. Teachers were asked to use it at least 70% of the time for practice in mathematics with individual students, using the Milliken Math Sequencer program or several other drill programs. The remaining 30% of the time was spent in literacy, logic games, language arts, or other appropriate uses. Three distinct patterns of usage were detected: parallel practice, paralleling regular lessons; daily practice, with the program changed daily/weekly to correspond to regular lessons; and spiral practice, involving varied practice activities. No judgments were made on the relative effectiveness of each pattern, but reactions were very positive. Overall, the effect on mathematics achievement favored the project group over a control group. Attitude toward mathematics was unaffected except in grade 2. An expected gain in knowledge of computers was noted, but no change in attitude toward computers occurred. However, students in the project group developed a dislike for making mistakes both in pencil and paper work and computer work. (Author/MNS)

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Utilization of Microcomputers in Elementary Mathematics

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UTILIZATION OF MICROCOMPUTERS IN ELEMENTARY MATHEMATICS

Final Report

Sol E. Sigurdson
Al T. Olson

Project Director
Vern Lowry

An Edmonton Public Schools Project
Jointly Funded By
Planning Services Branch, Alberta Education
Edmonton Public Schools

October, 1983

Abstract

In this study the microcomputer was used in grades two to six in an elementary school for a full school year in the Classroom Practice Mode. In this Mode of usage, the microcomputer was placed in each classroom for one-half day every day. The teachers were asked to use it, at least seventy percent of the time, for practice in mathematics with individual students. In doing this the Math Sequences (Milliken Publishing Co.) program was used as the basic program. Teachers also had several other drill programs from which to choose. The remaining thirty percent of the time was to be spent in literacy, logic games, language arts or any other computer program the teacher felt appropriate to the grade level.

In monitoring the instructional processes that the teachers used as they operated in the Classroom Practice Mode for the whole year, three distinct patterns of usage were detected:

Parallel Practice Pattern - The microcomputer mainly through the Milliken program provided a separate, parallel program to the regular classroom lessons.

Daily Practice Pattern - The teacher changed the program on a daily/weekly basis to correspond rather directly to what was being taken in the regular lessons.

Spiral Practice Pattern - The microcomputer was used to provide a variety of practice activities through a variety of software programs.

No judgements were made on the relative effectiveness of each pattern. Teachers' and students' reaction to this use of the microcomputer was very positive.

In monitoring the possible benefits that accrued to students, a comparison to a control group was made. The overall effect on mathematics achievement favoured the project group. Attitude to mathematics was not affected by the computer usage except in Grade two where a slight falling off in attitude to mathematics was detected. An expected gain in knowledge of computers was noted but no change in attitude to computers occured. However the students in the project group developed a dislike for making mistakes both in pencil and paper work and in computer work.

The project established the Classroom Practice Mode of using the microcomputer as an easily-implemented usage which causes very little disruption in the daily activities of the elementary school classroom. The usage resulted in achievement gains for most classes.

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Eric Brown
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Computers In the Classroom

Hundreds of teacher-hours and student-hours are being invested every year in using and learning how to use computers. The microcomputer, in particular, seems to have the power and flexibility necessary for successful classroom usage. The range of application is vast: literacy, programming, tutorial, practice, simulations, and testing, to name a few. No agreement exists on which usages are the most effective for students or most available to teachers. Simple programming languages, such as LOGO, are receiving considerable attention but data on their effectiveness is incomplete. A recent informal survey of elementary classrooms in the Edmonton Public Schools indicated many teachers using the microcomputer for providing practice in mathematics facts and skills. The current project attempted to implement a practice usage of the microcomputer in grades two to six in a typical elementary school in the Edmonton Public School System. The intention in doing this study was not to suggest that practice is the only, or indeed the most appropriate usage of the microcomputer in elementary schools. Practice was focussed upon for several reasons. First, the practice mode can be implemented with small financial outlay. Secondly, unlike programming or literacy, practice deals with content currently on the prescribed curriculum. Thirdly, teachers can, with little formal knowledge of computers, easily conduct practice sessions with the microcomputer. Lastly, practice seems appropriate for the full range of the student population.

The Report

This report deals with the implementation of a particular usage (practice) of the microcomputer in the elementary school. The seven teachers, which represented all the teachers in grades two to six in a small elementary school, used the computer as a vehicle for their students to practice basic skills of the mathematics curriculum. Each teacher had a microcomputer in his/her classroom every day for a half-day. During this half-day students were put on the computer on a rotating basis (10 minutes per turn). The teacher had a choice of several software programs to provide the practice activity. By choosing different programs for the students to work on, the teachers controlled the type of practice the students were getting. Teachers, in effect, could design their own computer-practice curriculum.

The purpose of the study was to monitor over the period of a full school year, the classroom usage of the computer in this manner and secondly to monitor the effect of the usage on students' attitude and achievement. The first section of the report, The Classroom Practice Mode--A Description, gives a detailed description of the Classroom Practice Mode as it occurred with many differences in the seven classrooms (grades two to six). This section is largely the result of the process monitoring which was done by interviewing the teachers and observing their classes. Details on the actual implementation procedures and on the

methods used in the process monitoring can be found in the second sections under Program Implementation (p. 40) and Design of Process Monitoring (p. 45).

The second section of the report, The Classroom Practice Mode--An Evaluation, deals with the experimental design and the analysis and results of the comparison of student attitude and achievement test scores to those of the control students.

The third, final, section The Classroom Practice Mode--Conclusions and Recommendations, summarizes all the findings and offers some projections. Because the experiment was conducted in the context of an on-going school program and over the course of a full year, experimental control was difficult to achieve. However the evaluation results combined with the description of the program and the teachers' reactions give a good picture of the total effect of using microcomputers in this Mode.

The Classroom Practice Mode--A Description

This description of the Classroom Practice Mode focusses on the actual use teachers made of the microcomputers: what programs they used, what sequence of programs they used, how they organized the students, how students used the programs and so forth. To give a fuller understanding to the program, teachers' observations on and reactions to the program and its effect on their classroom have also been given. This description has been organized into four parts.

1. Implementation--describing program features common to all teachers
2. Three Patterns of Teacher Usage--describing three "ideal types"
3. Details of the Classroom Practice Mode at Different Grade Levels
4. Observations and Teacher Reaction

Implementation

Seven teachers (grades two to six) were given the following guidelines for using a microcomputer which would be in their classroom for a half-day, every day.

1. For seventy percent of the time students will use the microcomputer (and appropriate software programs) for practice in mathematics.
2. For each student a period of from 5 to 15 minutes will be provided as often as a class rotation allows.
3. The practice in mathematics on the computer for each student will continue even though the rest of the class is having a lesson in another subject area.
4. The remaining thirty percent of the time may be used for any other type of computer activity: literacy,

mathematics games, or language arts software, for example.

5. The teacher must schedule, as much as possible, out-of-classroom activities, such as music and gymnastic time, during the half-day that they do not have the computer.

6. Although the teacher will have access to and inservice in (details of the inservice are given in Program Guidelines, page 41) many software programs, initially the students will use a computer-managed drill program (Math Sequences--Milliken) which records all student progress.

Within these six guidelines teachers had considerable leeway in their usage. In most instances, the half day would consistently be either the morning or afternoon. There was some variation in this as two teachers sharing a computer would arrange for one of them to have it one afternoon and next morning; this arrangement decreased the number of moves of the computer between rooms in a week. Teachers were discouraged from keeping it for full-days simply because the class inevitably had out-of-classroom activities sometime during the day. The intent of the Classroom Practice Mode is to have the computer in operation as much of the time as possible.

Most of the teachers assigned students to the computer in 10 minute intervals throughout the half day--even during the silent reading period. In general, the computer-managed drill program (Milliken) was used. The teacher put each student's name on the disk and after the student had signed-on, the computer kept track of what level the student was working on so that, upon signing-on again, the student

would be automatically assigned the level where he had left off. The Milliken program was, in general, set up to pass students to the next level if they scored 90% or better and put him back to the previous level if he scored less than 70%. Between these two percentages the student would repeat the same level.

The programs available in the Milliken software included addition, subtraction, multiplication, division, fractions, decimals, and percent. From 50 to 70 levels were available in each area. The grade two mathematics program only included say the first twenty-five levels in addition and subtraction, while the grade six program included all levels in all programs. The Milliken program provides the capability of assigning specific levels to students and the number of questions per level giving the teacher good control over the students' activity. The program besides managing the students' progress through the levels also recorded on the same disk, the students' marks on different levels and could display for the teacher the progress a student was making. The teacher could always tell what level the student was on, and how he had progressed to that point.

The Milliken program assigns questions and gives the student two tries at getting it correct before showing the student the correct answer. For complicated questions which require borrowing and carrying or algorithms such as long

division, the program has built-in prompting devices which can be put into operation by pressing the space bar. The prompts given by the computer are optional. In adding two column numerals, after adding the column on the right and putting the "units numeral" in the answer, pressing the space bar displays a question mark above the second column as a reminder to carry the "tens numeral". The value of the "tens numeral" has to be inserted in place of the question mark. If the space bar were not pressed the student could proceed as usual. For most Milliken programs, the student's answer is wrong only after two incorrect responses are made.

A detailed description of the Milliken program will not be given here. Suffice it to say, it is a comprehensive program, managing student progress, providing information to teachers, prompting student response, and providing immediate feedback to the student. For some reason, perhaps, because it stores the information on the students' progress or because of its graphics, it tends to be slower in presenting questions than simple drill programs. A second manner of using the Milliken program is as a source of questions where student information is not stored. By typing "DRILL" instead of the name, a student can ask for questions from any level. In this mode, the program gives the percent correct after a certain number of questions but does not store this information and loses track of the student's progress when the student "signs-off".

The teachers were given the Milliken program to use with their classes but were encouraged to try other programs, drill and non-drill, in mathematics and language arts. The programs (listed alphabetically in the Appendix A) available to the teachers included:

Mathematics

1. Milliken
   -several disks as previously mentioned
2. San Juan
   -speed drills
   -Boxes
3. DLM
   -Alien Addition
   -Minors Mission
   -Meteor Multiplication
   -Demolition Division
   -Alligator Mix (addition and subtraction)
4. Hurkle (MECC) (graphing activity)
5. Speed Drill (MECC)
6. Clock (Hartley)
7. Temperature
8. Geometry -Area and Perimeter
9. Apple - Darts
10. Shell Games (estimation)
11. Houghton Mifflin -several drills, game format
12. Moptown -logic game

Language Arts

1. Compu Read
2. Data Command
   -Tank Tactics (basewords)
   -Pit Pet Put (contractions)
   -Tennis Anyone (plurals)
   -Riddle Me This
3. Hartley
   -Multiple Skills
   -Vowels
4. MECC
   -Prefixes
   -Spelling
   -Utilities -creates crosswords, word find
5. Milliken
   -Reading Comprehension
   -Homonyms
   -Pronouns
   -Verbs
   -Alphabetizing

These lists do not include all the programs made available to teachers but give a good idea of the choice. Only the Milliken programs have the capabilities for managing the students' progress. For the most part the programs are simple drills (no record keeping) or questions in a game format.

The teacher selects the program to be used that week (or day) and turns the computer on. The first student would use the program for 10 minutes, say, and then call the next student. In this way approximately 10 to 12 students would get turns on the computer every day. In classes with 18 students, a student would get a turn almost every day. In classes with 28 students, a student would get a turn every two or three days. Teachers could choose the program they would use, the order of the students, the time (or the number of exercises) for each student, and the frequency with which any of these variables could be changed. All teachers began the year by using Milliken and generally settled on using it in a specific way. Every teacher developed his/her own computer usage pattern. Some stayed to using only Milliken, others used it less. Some varied the computer activity daily, others used the same program for weeks or months. For the purpose of convenience in reporting, three patterns of usage have been identified. Although these are, in a sense, ideal types, all seven teachers in the project tended to follow a pattern of usage

that gravitated to one or the other of them. No one of these patterns is deemed more effective or appropriate than the other. The pattern that a particular teacher chooses is a function basically of his or her teaching style plus class characteristics such as student maturity, range of student ability and size of the class.

Three Patterns of Teacher Usage

The three patterns of usage described below in detail are

Type A: Parallel Practice Pattern. In these classrooms the computer provided a separate drill program (using only Milliken) which ran parallel to the mathematics program and was not in general, affected by progress in regular classroom lessons.

Type B: Daily Practice Pattern. These teachers changed programs daily or weekly according to what was being taught in the classroom lesson. These teachers monitored closely the work of the student at the computer.

Type C: Spiral Practice Pattern. Students in these classrooms were exposed to a variety of drill programs - variety in content and format (including video games). The flexibility and ready access capability of the computer were utilized.

Type A: Parallel Practice Pattern

Typical of teachers who used this pattern was a grade four teacher. With very few exceptions, Milliken was the only program used. The students over the whole school year worked on the four fundamental arithmetic operations: addition, subtraction, multiplication, and division. The major portion of time was spent on the first three

operations. The only exception to using Milliken was at times such as the week before Christmas when students were allowed some games disks. Students were at the computer ten minutes per turn. The teacher assigned in general, 15 questions per level so that the students got through one or two levels per turn. The students worked at their own rate with the teacher making an arbitrary decision to change the topic from addition to subtraction to multiplication. In this way, two or three months were spent on each operation. The program being offered was a practice program operating in parallel to the regular curriculum but not being influenced very much by the pace of the regular curriculum. It was a separate, sequential program. Students marked their progress on a paper checklist which remained on the computer table. This simply allowed students (and the teacher) to check their progress and compare it to that of other students. Although print-out on students' progress was available, the teacher felt no need to use it. All of the students were progressing nicely, if slowly, with a 95% score on each level. Students were allowed to progress at their own rate and one girl, in particular, was well ahead of the rest of the class and even went beyond what was normally taken in grade four.

What were the students getting? Each student averaged about 25 minutes per week (in 10 minute periods) of practice in the basic operations. This amounts to about 10% of the

total mathematics program at this level. Characteristics of these practice sessions were

self-paced -The students received 15 questions per level and depending on their own ability, completed one, two or three levels per turn.

structured -The Milliken program is secuential in nature each level building on the previous.

success -All students (except for one or two) achieved at the 95% level.

exacting -Questions could only be done in one way with only exact answers accepted.

immediate feedback -This occurs even as an algorithm is being worked out, so that a student knows immediately when he's on the wrong track.

prompting -On longer and algorithmic exercises students (90% of them) used the prompting help given by the program.

novel -Although any initial glow would have worn off in ten months, students always enjoyed getting on the computer. It was a novel way of getting practice.

teacher-free -Students took these sessions in a teacher-free environment. The program did the grading. The activity was "shared" between the computer and the student.

no-teacher effort -Although this characteristic did not affect the student, the fact that the teacher did not have to grade these practice sessions was important to the teacher.

Classroom operation was simple. The student often started on the computer before the class lesson started. Regardless of the activity in the room, the computer was operating. The teacher ran it as a separate program so no

matter what the classroom activity--reading, language arts, or mathematics--as the student at the computer finished another took his place. Only seldom did students not wish to go on and this only because they, for example, wanted to finish an art project. Few exceptions, however, were allowed. The class (and teacher) viewed this as an important classroom activity. In view of the routine, compulsory nature of this activity, surprisingly, the motivation for the activity stayed high all year. The teacher used no motivational gimmicks. Students were probably attracted by their high success rate in the program, the non-frustrating nature of experience, and the obvious sense of progress. The sense of "being on their own" also probably contributed to their good feeling about the prograr. In fact, one of the unique features of the operation of this pattern is the hands-off policy by the teacher. She could easily make a non-obtrusive glance at the checklist and be assured that each student had passed each level with at least 90% correct and more likely 100% correct.

Part of the analysis of a classroom innovation is the extent to which it interferes with normal classroom operation. The only difficulty noted by the teacher was some confusion over whose turn it was. In general, a row by row procedure was followed and confusion sometimes arose over who had the last turn the previous day or over a

student being absent. The teacher did not stop the computer for any class lessons and, as did all teachers, found students easily regained their place in the lesson upon leaving the computer. To cut down on interruptions from students on the computer, she instituted a buddy system whereby one student was assigned to help students. Because the program is so complete and sequential, she found there was very little use of the "buddy" as the year progressed. Classroom observations indicated the computer's operation had no impact on the teacher's lessons. Students, even apart from the computer-related activity, were moving around - going to sharpen pencils, borrowing equipment, getting up to ask the teacher questions and so forth. In the teacher's opinion, the only possible change to her lessons might have been in slightly less emphasis in mathematics practice given to the whole class.

The teacher especially liked the Milliken program because it gave students corrections to their work and was so self-contained. During the brief experience of her class with "speed drill" programs she felt students were left in limbo wanting correct answers. With the students being left so much on their own, a computer-managed drill program was absolutely essential. About the only misgiving the teacher had about the program was the question of its effect on achievement. While she felt certain the experience wasn't hurting, she was not sure of its benefit. The mere fact

that an experience beyond what the students would otherwise get in her class was being provided, she felt, was positive.

Type B: Daily Practice Pattern

Typical of the teachers who used this pattern was a grade two teacher. In this classroom the Milliken program was used less than half of the time. Over the course of the school year, the teacher used two Milliken programs, addition and subtraction, plus five or six others. Besides working on the basic operations students were exposed to telling time, temperature, spelling, homonyms and several speed drills. But even more important than the relatively wide variety of topics was the manner of usage. In general, every one of her 20 students got on the computer every day for five to ten minutes. In each case, the students had specific tasks to do. Even when using Milliken, the teacher assigned certain levels to be done every day. Inevitably good students would finish quickly while poorer students took longer. The practice being offered to the students was in the mathematics area with which they were currently dealing. Obviously there were gaps in coverage. The teacher felt that to offer as complete a practice program as she would like, she needed good drill programs on Canadian money, place value, measurement, two-dimensional and three-dimensional shapes.

In addition to controlling the programs and the rate of progress, the teacher also controlled who was on the

computer and to some extent their activities while they were there. Although her usual pattern of assigning students was row by row, she often would not assign particular students to their turn at the computer until she knew she would be free to help them. Once the student was on the computer, she would help him/her as difficulties were encountered. Sometimes she would turn the computer so that she could see the screen from her position at the front of the class in order that she could monitor the student's progress as he/she worked on the program. In any case, she felt she had to watch the poorer students all the time.

At first glance, this usage of the Classroom Practice Mode seems somewhat restrictive. Her teaching philosophy and her general teaching style however, are complemented by this usage. A typical mathematics lesson would have 4 or 5 different activities. She believes there are many avenues through which mathematics can be learned. For example she would start with some explanation at the board, then ask students to come to the board to give examples of a concept. Next she would hand out manipulatives and follow this up with assignments from a workbook or a specially prepared handout. Her teaching was characterized by constant moving around the classroom, asking questions, asking for clarifications, always available to listen to a student's discovery or difficulty. Appropriately she treated the computer as another approach to teach content. This type of

teacher has to be constantly checking on how her charges are getting along offering encouragement and help every step of the way. She feels that her teaching has changed because of the Classroom Practice Mode. One activity in her lesson was drill in one form or another. She thinks the computer is taking over this function, probably doing at least as good a job, but freeing her to work with the class.

The classroom operation in this pattern of usage was essentially reasonably complicated. Daily decisions needed to be made on programs. Decisions of student order were needed during every class. The teacher tried to be aware of how each student was progressing. (Obviously this only applied to the six or eight students experiencing difficulty.) In agreement with her policy of "control", the teacher actually stopped the computer whenever she was teaching "something new" and it was usually stopped during "reading group". The teacher felt this meant about 15 to 20 minutes per half day of interruptions (down time). In any case, this amount of stoppage appears quite minimal and only slightly above the average computer stoppage over the seven teachers. Other than this, the teacher did not feel that the computer was interfering with classroom work. In fact, the Daily Practice Pattern of usage was highly integrated into the regular classroom activity. For the most part, students working on the computer at the back of the classroom kept right in step with the classroom activities

and quickly found their spot in the activity when they were finished at the computer.

The teacher did not especially like the Milliken program. The faster speed drills, she felt, were better. In any case, she had no need of the management and information that Milliken provided. She rather felt programs with visuals (clocks and thermometers) were more suited to her type of usage and grade level. She would willingly sacrifice management and student-progress information for visual displays, tutorials and speed. As it was, she was extremely positive about this usage of computers in the classroom. Any software programs that she finds that are more suited to her purposes can only improve the usage. Although the teacher stayed within the 70% guidelines for mathematics drill, she used a significant amount of language arts drill. If anything, she felt the children benefitted to an even greater extent from the language arts computer activities.

Although the teacher was unsure of the achievement benefits for her students, she liked using it and thought it was a "great thing even for the little children". Especially because she was able to integrate it into her instruction, any negative side-effects were minimal. The motivational appeal of the computer remained high all year. Her usage policy meant no student had frustrating experiences. They were not racing against anybody; there

was no pressure (except from the teacher) on them. They worked until they finished their assigned task. Apart from achievement and obvious motivational benefits, the teacher felt that students benefitted from having to concentrate on a precise task. Especially slower students are learning to concentrate. For this teacher, the computer is no magic. Slow students are still slow and have the most difficulty learning. They still have to be encouraged. But she feels the computer can be a very positive element in the classroom.

Before leaving the analysis of the Daily Practice Pattern, two points bear some comment. First, the type of practice the students get is dependent on the software programs. In any case, it is accurate, structured drill (answers required in a certain format) with immediate feedback. It can also contain visual displays, prompting, and timed activity. Practice with these characteristics would seem to be beyond what a classroom teacher could do without a computer. The second point is the flexibility of the Classroom Practice Mode in that it could be adapted to suit this teacher's style. We often think of teachers having to adapt to inflexible technology but here we see the tables turned. But of course, only a teacher's ingenuity and energy can bring together the randomness of youth with the cold precision of the computer.

Type C: Spiral Practice Pattern

Typical of the teachers who used this pattern was a grade six teacher. In this classroom, the Milliken program was used about three-quarters of the time. Over the course of the school year, the teacher used six Milliken programs - addition, subtraction, multiplication, division, decimals, and fractions. In addition to these six programs which formed about three-quarters of the computer time, the student used speed drills in the basic operations and decimals, several video-game drill programs on the basic operations and fractions plus drill and game programs on graphing, metric measurement, and metric estimation. So besides the six Milliken programs, the students worked on at least eleven other game, drill, and tutorial programs. Most of these programs are short non-sophisticated programs but they present mathematical concepts and operations in a different format than Milliken.

Although this teacher began the year by assigning 10 questions per level and 15 minutes per turn, he changed to 5 questions per level and 10 minutes per turn. In this way approximately 12 students got on per day, which in turn meant almost every student got on the computer every second day. (Considering lost time, every student would get 10 minutes on the computer twice a week which is less than ten percent of their total mathematics program.) The fewer questions per level and the short time per turn meant a

greater variety of material and levels of difficulty could be covered in the practice. The teacher also used the Drill mode in Milliken in which students would get questions in a given area without the computer keeping a record of it. When employing the Drill mode on Milliken, the teacher would select the area of work, such as multiplication or division, but he would often let the students select the levels (type of questions) that they wanted to work on. In some instances, he had all students working on precisely the topic of the day but he only did this for specific topics such as "rounding off". In the case of the speed drills and games, of course, no record of student progress was kept. Although he stated no position explicitly, the system the teacher used suggested a policy of, once a program was on the computer, the student, regardless of how fast he worked, getting 2, 3, or 4 ten-minute periods. In a sense, the microcomputer programs were viewed as an "opportunity" for students, of which they should make the best use possible. In general, programs were changed every two or three weeks. (The exception to this was the Milliken fractions program which, for some students, remained on for as long as 2 months.) To some extent, the content of the computer program was related to the topic with which the class was dealing but this was interspersed with review drill.

The assignment of students to the computer was according to a list posted on the wall. A departure from

this order was necessary only at times such as a student being out of the room. Once the student was working at the computer, the teacher paid little attention to him/her, except if he/she were having obvious difficulties. Difficulties were few as the teacher usually demonstrated to the whole class how a certain program worked before the students used it. Although he experimented with pairs of students working at the computer, several practical difficulties arising led him to abandon this procedure. The teacher confided that slower students working on their own were often not getting very much accomplished. He felt, however, that it was impossible for him while teaching the whole class to help this type of student. He admitted that perhaps this slower student did as poorly (or more poorly) on other types of pencil and paper practice. He especially confirmed his fear about the lack of progress of slower students in his experiment of leaving the fractions program (Milliken) on for over 2 months, at which time 10 students had completed the program while several slower students were only on level 10 or so. This problem either did not exist or did not show up as prominently in his usual Spiral Pattern of two or three weeks on a program. That is, maybe after two weeks of little progress on the fraction program, the slower students working on their own basically gave up: "I could leave the disk on till Doomsday and they'd never get through!" Whereas in the spiral approach, the shorter

constantly changing tasks served to keep the students' energy and interest up. Also, fractions is an admittedly difficult topic for a good portion of the students. Although he was concerned about the slower students at the computer, he did not achieve an adequate solution to the difficulty.

What, then, is the rationale behind the Spiral Practice Pattern of usage? The teacher saw the microcomputer as having the facility of easy access to any type of practice. He stressed the importance of having skills of mathematics, whether in addition or decimals, continually in front of the students. He disliked the teaching strategy of taking multiplication in November and not touching it again until June. His desire to spiral mathematics topics (or, at least practice in mathematics topics) could be easily fulfilled by the computer using either Milliken or non-Milliken programs. A second aspect of his rationale for the Spiral Practice Pattern was his concern for motivation. He felt his grade six students who had had some experience programming the microcomputer the previous year expected more out of the computer than routine practice programs. Changing the programs, and especially using those with a video game format, he found to be very appealing to the students. Using the versatility of the computer, together with some 17 programs, the students were continually encountering new formats and their image of the computer as a "high tech"

illustration of modern electronics was being reinforced. Although difficult to prove, the teacher, himself, probably possesses a "high tech" image of the computer which he may be trying to live up to. This brief analysis is in no way trying to say that the teacher is or is not justified in his perspective. In fact, the argument can be made that the modern classroom will benefit - psychologically, if not academically - from a "high tech, video-game, electronic" stimulus. Interestingly enough, his two month experiment with the fractions program (in which he decided to leave the fractions program on until everyone had completed it) seemed to confirm his philosophy even more. He was disappointed with the routine, plodding presentation of the computer-managed program, even to the point of saying that next year the only Milliken program he would use was the division program. He felt it was more beneficial if the teacher, himself, managed the areas for drill using a "spiral" concept of curriculum. The teacher would probably even have agreed with a "random" practice pattern using various formats which could still maintain a high motivation level in the students.

The classroom operation of the microcomputer in the Spiral Practice Pattern required teacher monitoring. The teacher was continually sensing the students' reactions to the programs. Decisions to change programs were governed by motivational level as much as by student progress through

the program. In the case of games, it took one or two sessions for the students to become familiar with their operation before a practice benefit could be realized. The teacher, in his regular teaching, used a lot of group activities and sometimes they were of such a nature that the computer operation was stopped. Interruption to the computer usage also occurred during special testing periods. This stoppage amounted in total to about one hour per week. Apart from this, the teacher reported little interference from the computer operation. Although for the "sake of my own sanity" the teacher "tuned the computer out", he kept close enough contact to enable him to monitor it in the manner indicated earlier. As most teachers did, he felt students at the computer could keep up with their class lessons and had no difficulty finding their place.

Although the teacher was extremely sensitive to motivational factors of his class, and though he continued experimenting with its usefulness, he remained positive about the Classroom Practice Mode. For his style of usage, he does not need computer-managed programs; he would like variety--games, speed drills, programs with prompts, and programs on a variety of content. He explored LOGO and Montown, activities which would take him beyond simple practice but which still operated well within the area of mathematics. He felt he could use most of the software that he had seen, another year. He will continue using the

computer in the Classroom Practice Mode but he feels literacy, programming, and problem solving objectives might also be considered. Almost whatever is done, students will benefit from interacting with the modern "high tech" world. If the advantages of the microcomputer in his classroom were not readily apparent, neither were any negative side effects. Sure hassles arose over student order; students complained when an exciting activity was disrupted; slow students seemed not to benefit as much as faster ones; extra effort was required to move the computer from the classroom across the hall; still, students complained if the computer wasn't there in the morning and the teacher believed that the ten percent of the mathematics program on the computer was an important contribution to his mathematics classroom and curriculum.

Details of Classroom Practice Mode at Different Grade Levels

Although all of the seven teachers in the project developed their own system of using the Classroom Practice Mode, each can be typed into one of the three "ideal types" described above. Below are given details of each teacher's usage including the type of usage pattern, programs used and characteristics of their usage pattern that stand out. (Detailed identification of programs can be found in Appendix A.)

Grade Two--Type B (Daily Practice Pattern)

Programs: Milliken -addition and subtraction
San Juan -Boxes
Clock
Temperature
MECC -spelling
Milliken -Homonyms

Format: This is the teacher described as ideal Type B. She integrated the microcomputer programs into her curriculum. She would like more programs for complete coverage of the curriculum. She used Milliken less than any other teacher.

Grade One-Two Split--Type B (Daily Practice Pattern)
Grade one students used the program minimally.

Programs (Grade Two): same as grade two teacher

Format: The teacher had no particular order of assigning students. She often gave larger (longer) assignments to children who needed it more. She kept track of what the students were doing on the computer. Sometimes she used computer activity as a reward for good work or good behavior. She felt this particular usage of the computer was mainly for "practice" and subsequently, that students should know how to do the work before they went on a program. Students at the computer completed specified tasks, for example, level 12. Her students felt it was a "real treat" to get a turn on the computer and sometimes tried to extend the time they were on by answering slowly.

Grade Three--Type C (Spiral Practice Pattern)

Programs: Milliken -addition
-subtraction
-multiplication
-division
DLM -Alien Addition
-Minus Missile
-Demolition Division
-Alligator Mix
MECC -speed drill
MECC -word game
MECC -memory game

Format: The teacher perceived grade three as a time for computational drill so practice was very important. At the beginning of each lesson he wrote a list of names on the board along with times. Students followed this easily. He used Milliken about 60 percent of the time and broke up the use of Milliken with games and drills. He thought the students benefitted by practice games which he often had them playing in pairs. One day he especially likes to tell about he had two computers with two kids at each one playing practice games. The better students, he thought, were really getting bored with Milliken so he tried to use as much variety as possible. The computer was no bother so he seldom stopped it. The computer to him, was an opportunity for students to get extra, interesting practice which could be best maintained through a varied spiral program.

Grade Four--Type A. (Parallel Practice Pattern) After spring break, she used an enrichment program (Moptown) for two weeks.

Programs: Milliken-addition
-subtraction
-multiplication
-division
-decimals
San Juan-speed drills
Moptown (a logic program dealing with attributes of objects, used only as enrichment with average or better students.)

Format: This teacher used Milliken 90 percent of the time. Students got 10 minutes per turn. The order of Milliken programs was addition, subtraction, multiplication, division, and decimals. Students checked off their progress on a checklist. Because some students progressed more rapidly than the rest of the class, an enrichment activity was provided for them.

Grade Four-Five Split--Type A (Parallel Practice Pattern)

Programs: Milliken-addition
-subtraction
-multiplication
-division (grade five students mainly)

San Juan-speed drills
MECC-Hurkle
Shell games (estimation)

Format: This teacher has been described as the typical Type A. The grade five students in her class progressed more rapidly than the grade fours which resulted in their using a different program. The students quickly got used to changing disks. For many of the programs the students received 15 problems per level.

Grade Five--Type A (Parallel Practice Pattern)
(Although this teacher supervised the Classroom Practice Mode, his students took mathematics in another room from another teacher. The mathematics teacher did some computer literacy work during the mathematics classes.)

Programs: Milliken-addition
-subtraction
-multiplication
-division
-decimals
MECC-Hurkle
San Juan-speed drills

Format: Although this teacher is categorized as Type A, he switched back and forth between the five Milliken programs. The other two programs were used very little. His students recorded their progress on a checklist for handy reference. The teacher continued to feel frustrated by what he perceived to be a lack of progress, especially in the slower students.

Grade Six--Type C (Spiral Practice Pattern)

Programs: Milliken-addition
-subtraction
-multiplication
-division
-decimals
-fractions
-percent
San Juan-speed drills
D.L.M.-Meteor Multiplication
-Demolition Division

Houghton Mifflin-game drills to parallel grade six curriculum
MECC-Hurkle
-Metric Estimation
-Metric Measurement
-Metric 21
Apple-Darts

Format: This teacher has already been described as a typical Type C.

Observations And Teacher Reaction

Throughout the year teachers expressed their observations on their use of the computer. These observations varied somewhat depending on the usage pattern the teacher was employing. Several observations were common to all teachers. Motivation, for example, was high in all classes. Type C users felt they had to work at motivation but they were successful. If a computer was unavailable on a given half-day, before anything else started the students wished to know where "their" computer was. On days when the neighbouring room wasn't using it, a class might be given a special treat and use it for a full day. The exact source of this motivation is not clear but is probably a mixture of computers being high-profile technology, students anxious for a "break" from class work, programs that guaranteed high success for almost every kid, and teachers obviously enthusiastic about the instructional potential of this new technology.

An important concern in every classroom is that students at both ends of the ability range are being served. In all classes, except those of Type B users, better

students were allowed and encouraged to work ahead. In some instances students who had completed the specific program were given "enrichment" games and activities. However, almost all teachers expressed concern over slow working students. Left alone on the computer, these students, often lacking the ability to concentrate, accomplished very little. In the Type B classes, these students simply got longer turns. In Type A, the result was, for example on a decimal program (Milliken), two students on level 6 and 8 while two others were on levels 34 and 35. One Type A teacher said in frustration about the computer program "Poor kids can't do it and good kids don't need it". Except motivationally, she conceded, it's good for all of them. Another Type A teacher felt girls work much better than boys on this computer task. A Type C teacher claimed he had "a lot of doubts about having (slower) kids working without teacher involvement". In most instances the concern was for low achievers but there also appears to be a group of students who achieve fairly well but are simply slow "plodders". These latter are not gaining maximally from working alone on the computer. This concern for the lower part of the range (both in achievement and work habits) is a problem that should be addressed very carefully by users of the Classroom Practice Mode. One possible approach is for the teacher to try to interact more with the student and the computer. Also these students could be put on different

programs. Or indeed, the computer time could be treated as a (much needed) motivational break for some of these students. But in any case distinguishing between slow workers and low achievers would seem to be essential.

Although this study monitored student achievement and attitude, teachers had their own appraisal of the benefits of the program. As stated earlier all agreed to the motivational benefit. Type B teachers were probably most confident in their assessments of achievement benefits because the computer activities related most directly to daily lessons, particularly with regard to specific programs such as Clocks and Temperature. Some were convinced the "good and average" were benefitting. Others admitting they had no evidence, just felt good about the computer usage. Still others, while claiming as much could probably be done through daily pencil and paper drill, sensed more was going on (immediate feedback, prompting, success) than, maybe, they were aware of. In any case, the teachers will be anxious to see the results of the product monitoring.

One of the most interesting questions, especially in view of the apparent inconclusiveness over the achievement benefit, is to what extent the computers are a disruptive or negative element in the classroom. On the surface, having students moving to and from the computer continually every ten minutes throughout the half-day would seem to be disrupting. Not so. The observer's feeling was, at times,

that the computer was one of the more stable elements in the classroom. Elementary school classrooms are very busy places. The orderly procession of students to and from the computer went on unnoticed. Students were anxious to have their turn so there was little chance of the computer remaining idle. In the middle of a "formal" lesson (teacher explaining some mathematical concept) a student would get up and move to the computer, stay for ten minutes, come back, and pick up as if he/she hadn't been away at all. There are at least two reasons for this. First of all there is a lot of continuity in the lessons in the average classroom so students can easily fill in the gap. Secondly, the student, at the back of the room, probably, between questions, listened with one ear to the lesson. Students working at the computer were seen to raise their hand, absentmindedly, to respond to a question the teacher asked in the context of a lesson.

If this movement to and from the computer didn't bother the students, perhaps even more surprisingly it didn't bother teachers. As noted earlier, Type B teachers, had time to control the movement of students to the computer. Some teachers admitted to having, at times, to fill in a "10 minute gap" for a student. But in general this was no problem. Most teachers admitted to stopping computer activity 30 to 40 minutes per week (Type B teachers more than others). But two teachers claimed they almost never

stopped the computer. Of course the essence of the Classroom Practice Mode is that the computer operate as much as possible. In addition to this stoppage, an additional hour per week of unavoidable out-of-class activity resulted in a stoppage plus the inevitable assemblies, school guest speakers and so on. Afternoon computer users seemed especially to lose out here. The one exception to the above claims that the Classroom Practice Mode was not a disruptive influence in the classroom occurred when a student in the midst of a group activity or art project requested to miss his/her turn. Sometimes requests were granted, other times not. Some teachers allowed flexibility and postponed the student's turn.

Although there was not much disruption of classes, teachers (except for Type B teachers) did not have time to monitor computer activity very closely. In general, there was no need to monitor since all students scored in the 95 percent range on the Milliken program but helping slower students, getting new programs started, and encouraging all students to attend to the task would simply increase the effectiveness of the Classroom Practice Mode. In only two classrooms did teachers find it convenient to appoint a student to act as a helper for students having trouble with their program. In one case, it was a split class where the teacher found herself under extreme time pressure. Certainly as teachers became more confident in the use of

this Mode, they will see the benefits (whether they are Type A, B, or C users) of such monitoring and find ways to "spread themselves a little thinner yet".

In most of the classes, especially Type A classes, the Classroom Practice Mode ran on its own. Student computer-monitors (like blackboard monitors) brought in the computer, set it up and often the student whose turn it was began his/her program before the rest of the class was ready for work. From there on with the order known, except for the odd bit of hassle, other students followed. The computer, generally, kept running with a substitute teacher. Even the presence of a student teacher in three of the classrooms caused no disruptions to the computer program and although the student teachers did not become involved in its operation, they felt it was not disruptive and probably beneficial. In every case, the computer found its place at the back of the room, generally with the student in full view of the class and the teacher. It became quite an accepted part of the classroom scene. Students working in class paid very little attention to its operation even when the programs had potentially annoying sound effects.

The purpose of the study did not include evaluation of software but the teachers' reactions to it deserve to be noted. Type B and C teachers in general felt Milliken was not especially useful for their purposes because of their usage pattern and partly because the mathematics content of

Milliken did not correspond well with their mathematics curriculum. Type B teachers wanted short, simple, fast programs which were easy to "set up". They would also appreciate programs on a wide range of content including place value, money, 2-D and 3-D shapes and measurement. They also appreciated programs that had visual displays, prompting (a lot of which Milliken has) and some tutorial dimension. In particular, Type B teachers had no need for Milliken management. Type C users both claimed students were bored with Milliken; one claiming another year the only Milliken program he would use was the division program. They felt the versatility of the computer could be employed to present a wider variety of drill and non-drill activities. Both Type B and C users found a lot of language arts programs to be very effective and maintained the Classroom Practice Mode could be used to good purpose in this subject. Type A users on the other hand appreciated the management and prompting functions of Milliken. They did not use many other programs but felt something should be available for enrichment.

The Classroom Practice Mode was conceived as a starting point for computer usage in elementary schools. It requires little specialized computer knowledge on the part of teachers and as we have seen, can function independently of the classroom teacher. One of the objectives of the innovation was to introduce teachers to computer usage so

that they could then go on to other applications. In general, the project teachers have not learned much about computers, certainly not about programming. The Classroom Practice Mode only required teachers to get a software program "up." For the majority of teachers, that is all they learned. Most of the teachers are still not completely familiar with the Milliken program which they used for ten months. The five days of inservice that the project conducted was sufficient to get the Classroom Practice Mode off the ground. Much of this time was spent on learning the details of the Milliken program. Some time, on describing and discussing the Classroom Practice Mode. The remainder, on familiarizing teachers with several available software programs. But much greater time would be needed before teachers could feel comfortable with anything in microcomputers beyond using these software programs.

The school based consultant was a vital part of the project, running inservices, solving daily problems and serving as a catalyst for the project teachers. Due to severe time limitations her work was focussed on keeping the project going rather than "educating" the teachers. In retrospect, if teachers are to broaden their perspective on the use of computers in the classroom, a conscious effort must be made in that direction. The current project did not achieve it. It will not happen on its own. Teachers are busy people both inside and outside the classroom with

neither the time nor energy to delve into specialized knowledge unless it directly affects their work. Educating the whole teaching force to software, programming and literacy uses of the computer in the classroom will require massive resources. The process monitoring in this study suggests that computers (with minimal effort) have a place in the elementary school classroom. This is a start but only that. Schools need a lot more information before the computer makes its maximal contribution.

The Classroom Practice Mode--An Evaluation

Statement of the Problem

The problem investigated in this study is whether a microcomputer in a classroom, used almost entirely for practice in mathematics, can contribute to student learning. The primary concern, however of a curriculum development-implementation project of this type is that the program does, in fact, become a reality in the classroom. Having established this in the previous section (p. 4-38), the second concern is whether the "hoped for" benefits were realized. In this section, the over-all design for the study is elaborated upon and findings are reported. Two types of monitoring were made: process monitoring (an investigation of the actual program as offered in classrooms and the effect it had on classroom procedures in general) and product monitoring (an investigation of student benefit in achievement, attitude, and computer knowledge). Although the results of process monitoring have already been reported, details of the procedures will be given.

The Setting

The Classroom Practice Mode was implemented in a small school (150 students--grades one to six) in a lower middle-class community in east Edmonton. Like all older districts, the school here is experiencing a decrease in enrollment and so houses another program for mentally handicapped students. The project was restricted to classes

of regular students only. Eight teachers (grades one to six) were involved. The grade one class, however, did not become really involved in the study. Because the school had five microcomputers, four could be shared among the eight teachers (and classrooms) with the fifth being used by resource room teachers. Seven teachers (excluding grade one) participated in the practice usage of the computer.

Program Implementation

The implementation philosophy of the project was to give teachers a) certain guidelines--as few as possible, b) a selection of software materials, c) consultant support, and d) inservice on typical practice programs. From here, teachers were to develop their own system of usage, select practice programs that they felt appropriate, and in general use the computer in the most effective manner while they had it in their classroom. This philosophy of implementation runs the risk of teachers straying from the original intent of the implementation but allows the teachers the freedom to conduct only classroom activities that are deemed appropriate by teachers in the classroom. It also maximizes the input of the classroom teacher into the implementation so that the curriculum program being implemented belongs more to the classroom teacher. It is to be expected then that the type of practice program would vary considerably from classroom to classroom. Fundamental to this type of implementation is the teachers having a full understanding

of the intent and philosophy of the innovation. The guidelines being understood, the teacher is asked to follow them in developing the most appropriate program.

Program Guidelines

The seven teachers (grades two to six) knowing they would have a microcomputer in their classroom for a half-day, every day, were given in September the following guidelines.

1. For seventy percent of the time students will use the microcomputer (and appropriate software programs) for practice in mathematics.

2. For each student a period of from 5 to 15 minutes will be provided as often as a class rotation allows.

3. The practice in mathematics on the computer for each student will continue even though the rest of the class is having a lesson in another subject area.

4. The remaining thirty percent of the time may be used for any other type of computer activity: literacy, mathematics games, or language arts software, for example.

5. The teacher must schedule, as much as possible, out-of-classroom activities, such as music and gymnastic time, during the half-day that they do not have the computer.

6. Although the teacher will have access to (and inservice in) many software programs, initially the students will use a computer-managed drill program (Math Sequence--Milliken) which records all student progress.

Three days of inservice were given to the teachers on the operation of the microcomputer, training in the use of the computer-managed drill program (Milliken), familiarity with several other software drill programs in mathematics,

and other software and games in language arts. During the year two additional inservice days were held focussing on familiarizing the teachers with additional software that was available. The teachers were given little information on programming the microcomputer. In addition to the software familiarization, brief discussions were held on how teachers were implementing the Classroom Practice Mode.

The name, "Classroom Practice Mode," suggests that the computer is used in the "classroom," perhaps in some corner but, within easy access of the teacher. This, as opposed to the computer being located in a computer center under the direction of an aid or resource room teacher. The "practice" term suggests the type of activity in which the student is engaged. The word "mode" suggests that this is a particular type of long-term usage. The intent was to use the computer in this fashion for a full school year.

Conditions for the Study

The program was offered by the classroom teacher, in the classroom, within the mathematics program for a full school year. The idea was that the program be viewed as a regular school program by the students and even by the teachers. Offering the program in this way detracts from the experimental control but offers three advantages. First, the permanence of the program makes it part of the school environment. Secondly, the benefits, especially improvement in student attitude would only show up after

long exposure to the treatment and perhaps not even then. Thirdly, a good part of a curriculum development "experiment" is whether the program can maintain its integrity once it is "in place." The attempt, then, has been to make the program as "ecologically" sound as possible.

In a study of this nature, which implements a program in a regular school operation some loss of experimental control is inevitable. The comparison to the control school is made on the assumption that the only difference between the two schools is the Classroom Practice Mode. But usually, the environment within which experimental teachers work is richer than that of a regular school. Several elements may have contributed, in this case, to making the classroom environments richer. First, the project was able to appoint a computer consultant who worked in the school one full-day equivalent per week. The consultant was able to provide inservices, help with any problems of computer operation, evaluate and make suggestions for software on practice programs, and help the teacher get print-out of student information from the computer-managed drill program. In any case, the consultant's presence was a constant source of security and inspiration to the seven teachers in the project. In addition, the consultant, as a part of her regular teaching load, taught literacy to the grade five and six students. In this way the grade five and six students

became more confident and competent in computer operation generally. Therefore the classroom teacher for these grades had several experts to call on within the class when minor difficulties were encountered.

Another element affecting the school conditions of the project was the monthly presence of the project interviewer and classroom observer. His two-day monthly visits were clearly anticipated by the teachers, most of whom, at least, prepared themselves mentally for the visit. Also, the actual discussions with the interviewer encouraged teachers to review their policies, to reflect on their teaching and in some cases, to accept suggestions made by the interviewer for trying different procedures or software. Although the interviewer tried to keep his role to that of monitoring instructional processes, discussions would inevitably lead to exploring alternatives.

Finally, the main positive influence on the project serving to enrich the classroom environment was the mere presence of the computer in the classroom. Modern societal trends serve to promote the idea that computers are good, exciting and "with-it".

Monitoring

Over the course of a school year while the Classroom Practice Mode was being used in the seven classrooms, the researchers were interested in monitoring the program, as it developed, and the effects the program had on the students:

process and product monitoring respectively.

Design of Process Monitoring

Although the results of this monitoring have been presented in the first section, The Classroom Practice Mode - A Description, details of the procedures used to gain the information are presented here. First of all essentially two process questions were posed:

1. How was the Classroom Practice Mode being implemented in each classroom? What particular form did it take? Why did it take the form it did?

2. What was the effect of the Classroom Practice Mode on mathematics instruction? How was instruction in subject areas, offered while the computer was in the classroom, affected?

In order to answer these two areas of concern, the researcher visited the school two days each month, September to June. During each visit he observed the same three teachers (selected at random) for a half day. He interviewed each of these teachers for a half hour after every observation. All interviews were audio-tape recorded and later analyzed. The remaining four teachers were observed four times (half hour per observation) over the course of the year. Although all interviews and observations were informal, the focus was to gain information on how the teachers were conducting the Classroom Practice Mode and how it was affecting their classroom instructions. The analysis of audio-tape recording and observational data resulted in the description of the Classroom Practice Mode given in the first section.

Design of Product Monitoring

The product assessment was multi-faceted featuring a number of instruments administered at various times. These instruments and their times of administration are summarized below:

Instrument	Project School	Control School	Date
Elementary Mathematics Survey Test Gr. 2, 3, 4, 5, and 6	x	x	Dec., 1982
Survey of Mathematics Attitude			
Div. I (Gr. 2-3)	x	x	Dec., 1982
	x	x	June, 1983
Div. II (Gr. 4-6)	x	x	Dec., 1982
	x	x	June, 1983
Survey of Computer Attitudes	x	x	June, 1983
Computer Questionnaire	x	x	June, 1983
Edmonton Public School Board (EPSB) Mathematics Survey Test Gr. 2, 3, 4, 5, and 6	x	x	June, 1983
EPSB Mathematics Survey Test Gr. 2, 3, 4, 5, and 6	x		June, 1982
	x		June, 1981
	x		June, 1980
EPSB Elementary Reading Test (Comprehension) Gr. 2, 3, 4, 5, and 6	x		June, 1983
	x		June, 1982
	x		June, 1981
	x		June, 1980

The project school refers to the school which utilized the Classroom Practice Mode. The control school was a comparable elementary school in a comparable community. The control school used the microcomputer to a very limited extent. The assumption upon which the product monitoring is based is that the project and control schools differed only in that the project school used the Classroom Practice Mode while the control school made very limited use of the microcomputer. The numbers of students in all grades in both schools was small making actual statistical tests somewhat unreliable. In the case of the attitude tests, statistical procedures were not used. The data was simply examined for patterns.

Findings of Product Monitoring

In the product assessment the resulting data were analyzed descriptively to determine how students responded to specific items and groups of items. Also, the data were analyzed to compare the performances of the project school and the control school. These analyses will be presented for each of the instruments in the sections that follow.

Achievement

Within the product assessment there was a need to show comparability in mathematics skills between the students in the computer project school and students in the control school. To do that the mathematics skills were compared in December, 1982, using the Elementary Mathematics Survey Test

and in June, 1983, using the Toronton Public School Board Mathematics Survey Test. The Elementary Mathematics Survey Test was developed specially for this project using the EPSB Mathematics Survey Test as a model. The analysis of these testings are presented below.

On both tests, a subtest consisting of items relating to number and operations was identified, the idea being that differences would be most likely on number and operations items which were closely related to the practice the students received in the Classroom Practice Mode.

In both the December and June testing, two scores are given:

1) A total (mathematics curriculum) score and

2) a subtest (number and operations) score.

Using the EPSB Mathematics Survey Test (June, 1982) scores, the project and control classes were compared. Initial (pre-treatment) differences between classes was found to be statistically significant in

Grade 3 and 5 favouring the control classes and

Grade 4 and 6 favouring the project classes.

However the December comparison, in Table 1, showing the results of a t-test with adjustments for unequal variances, shows statistically significant differences in

Grade 2 favouring the control class and

Grade 6 favouring the project class.

Except for grade 6, then, initial differences between the

project and control school seemed to have disappeared by December.

	December Total Test			December Number and Operations Subtest		
	P	C		P	C	
Grade 2	22.7	25.2	*C	18.5	20.0	
Grade 3	35.0	35.2		30.9	31.3	
Grade 4	30.8	33.9		29.8	31.8	
Grade 5	48.3	47.3		39.0	36.6	
Grade 6	35.0	31.0		25.3	20.1	**P

Table 1.
December Achievement - Total and Subtest Scores.
Comparison of Project(P) and Control(C) School
* indicates statistical significance at the .05 level
** indicates statistical significance at the .01 level

	June Total Test			June Number and Operations Subtest		
	P	C		P	C	
Grade 2	55.0	56.0		30.6	30.8	
Grade 3	55.5	46.8	**P	32.2	27.4	**P
Grade 4	45.5	50.9	*C	30.2	34.2	*C
Grade 5	43.5	33.1	**P	27.4	19.6	**P
Grade 6	47.2	38.4	**P	28.6	23.6	**P

Table 2.
June Achievement - Total and Subtest Scores.
Comparison of Project (P) and Control (C) School
* indicates statistical significance at the .05 level
** indicates statistical significance at the .01 level

The project grade two class was slightly below in December. Table 2, however, shows the grade two classes as being equal in June which indicates an improvement for the project class. Also in June, Grades 3, 5, and 6 results all favour the project classes with an average difference of almost 10 points (raw score). Only the Grade 4 results favour the control school with a difference of means of 5

points.

As a total group the project school (except in grade 4) seems to have gained in achievement and certainly, at least, held its ground. Surprisingly, the number and operation sub-test scores were not affected more strongly than the total scores. This seems to suggest that although the computer drill was mainly on computation, it affected the total curriculum.

Attitude to Mathematics

Two versions of this instrument were administered in December, 1982, and June, 1983. One version was given to Grades 2 and 3, while the other version was given to Grades 4, 5, and 6. These results are summarized below.

For the Division I instrument the responses have been grouped for convenience in analysis and description. The first group comprised 20 items focussing on the students' reaction to a mathematical task done by the individual. The next group of ten items focussed on the students' reaction to mathematics in more of a class-teacher context. Each of the last five items involved a single word which was a label for a mathematical procedure or task to which the students were to react. The Survey of Mathematics Attitude - Division I can be found in Appendix B.

	December		June	
	P	C	P	C
Individual Math (Items 1-20)	55.4	52.4	54.3	51.6
Class-Teacher Math (Items 21-30)	28.0	25.4	26.4	26.0
Item 31 "Counting"	2.9	2.6	2.9	2.8
Item 32 "Adding"	3.0	2.7	2.7	2.8
Item 33 "Computers"	3.0	2.9	3.0	2.8
Item 34 "Subtracting"	2.8	2.4	2.6	2.4
Item 35 "Geometry"	2.8	2.6	2.7	2.7

Table 3.
Attitude to Mathematics - Grade 2
Comparison of Project(P) and Control(C) School
(Numbers given are aggregates of average scores)

	December		June	
	P	C	P	C
Individual Math (Items 1-20)	51.8	50.5	44.9	51.1
Class-Teacher Math (Items 21-30)	25.5	25.4	22.7	25.2
Item 31 "Counting"	2.8	2.7	2.5	2.7
Item 32 "Adding"	2.9	2.8	2.8	2.9
Item 33 "Computers"	3.0	2.9	3.0	3.0
Item 34 "Subtracting"	2.2	2.4	2.0	2.4
Item 35 "Geometry"	2.7	2.4	2.6	2.3

Table 4.
Attitude to Mathematics - Grade 3
Comparison of Project(P) and Control(C) School
(Numbers given are aggregates of average scores)

Of the fourteen comparisons made in Table 3 and 4 in the December column, 13 favour the project classes whereas in June only 6 favour the project classes. Also for the project schools, of the 14 measures made in December all 14 of them either dropped or stayed the same by June. Whereas for the control school of the 14 measures only 7 dropped or stayed the same. This does suggest that the computer may have initially given a boost in attitude to mathematics to

the grade 2 and 3 project classes. However by June this improved attitude dropped off.

The Division II Mathematics Attitude Survey was given in grades 4, 5, and 6. It consisted of 34 items which were divided into two parts. Part 1 comprised 24 items using a mixture of pictures and written statements that pertained to mathematical tasks. Part 2 comprised 10 written items that pertained to personal feelings about mathematics. In the summary tables below the two scores are reported for each administration. The numbers in these tables are aggregates of average scores. The Survey of Mathematics Attitudes -Division II can be found in Appendix B.

	December		June	
	P	C	P	C
Mathematical Tasks (Items 1-24)	59.7	65.8	59.8	65.9
Personal Feelings (Items 25-34)	25.5	26.6	24.3	26.3

Table 5.
Attitude to Mathematics - Grade 4
Comparison of Project(P) and Control(C) School

	December		June	
	P	C	P	C
Mathematical Tasks (Items 1-24)	60.5	57.5	59.1	59.5
Personal Feelings (Items 25-34)	24.5	23.7	24.3	24.3

Table 6.
Attitude to Mathematics - Grade 5
Comparison of Project(P) and Control(C) School

	December		June	
	P	C	P	C
Mathematical Tasks (Items 1-24)	57.5	58.0	58.8	60.0
Personal Feelings (Items 25-34)	24.3	25.0	24.7	25.1

Table 7.
Attitude to Mathematics - Grade 6
Comparison of Project(P) and Control(C) School

No tests of significant differences were made. There is very little discernible pattern here. Somewhat surprisingly, the Grade 5 and 6 project classes which achieved much higher than the control classes do not have any better attitude to mathematics than the control classes. As would be expected from the achievement results at the grade 4 level the control class have a better attitude to mathematics than the project class. There is no movement in this attitude score from December to June for either group.

Attitude to Computers

A single Survey of Computer Attitudes was administered to all grades 2-6 in both schools in June, 1983. In responding to the items, the students filled in a "happy face," a face that was neither happy nor sad, or a "sad face," depending on their reaction to an item. In the summary tables that follow the numbers of students that responded in each of these categories is recorded. At division I only the Grade 2 scores are available and reported. However at division II students from the three grades 4, 5, and 6 are grouped together. Key phrases are

given in the items below. The actual instrument is in Appendix P.

	Happy		Neutral		Sad	
	P	C	P	C	P	C
*1. Working with computer	96	73	4	27	0	0
*2. Addition on computer	89	57	7	33	4	10
3. Games on computer	89	96	7	4	4	0
4. Addition on pencil and paper	59	51	30	24	11	25
5. Subtraction on computer	74	69	22	22	4	10
6. Having a long time on computer	74	65	15	26	4	10
7. Practice mathematics on computer	85	73	11	26	4	2
8. Making pictures on computer	89	88	11	8	0	4
9. Wrong answers on computer	0	12	33	31	67	57
*10. Sharing a computer	89	61	4	22	7	18
11. Answering mathematics on computer	85	75	11	20	4	6
12. Answering computer's questions	93	75	7	22	0	4
13. Right answers on computers	96	92	4	8	0	0
14. Figuring how a computer works	82	65	18	31	0	4
*15. Mistakes with pencil and paper	7	22	33	10	59	69
16. Many computers in school	89	82	7	10	4	2
*17. New things on computer	100	80	0	18	0	2
18. Being taught by a computer	63	76	18	12	18	2
19. Very short time on computer	22	22	19	14	59	65
20. Computer to do all school work	81	63	4	6	15	31

Table 8.
Attitude to Computers - Grade 2
Comparison of the Project(P) and Control(C) School
(Numbers given in columns are percentages)
* statistical significance (.05 level) using a Chi square test

Four items which indicate differences all show the project group having a more positive attitude. The fifth item shows the project group more negative about making mistakes. Of the 16 items which refer specifically to "doing things with the computer," 14 are responded to more positively by the project group. As might be expected the control group, because they had very little computer experience, indicated a greater number of students in a

neutral position on 13 of these 16 items. So although the evidence in Grade 2 is not overwhelming, the project group is slightly more positive toward computers.

	Happy		Neutral		Sad	
	P	C	P	C	P	C
1. Working with computer	72	72	6	4	0	0
2. Addition on computer	62	56	16	19	0	3
3. Games on computer	77	73	1	3	0	0
4. Addition on pencil and paper	31	39	23	17	24	19
5. Subtraction on computer	48	51	28	26	2	1
6. Having a long time on computer	69	70	7	6	1	0
7. Practice mathematics on computer	69	60	9	13	0	3
8. Making pictures on a computer	73	65	5	9	0	2
*9. Wrong answers on computer	4	18	25	27	49	31
10. Sharing a computer	42	44	26	25	10	6
11. Answering mathematics on computer	58	52	20	18	0	5
12. Answering computer's questions	64	62	13	13	1	1
13. Right answers on computer	73	69	5	5	0	2
14. Figuring how a computer works	58	63	12	7	8	5
(*)15. Mistakes with pencil and paper	6	16	19	19	53	43
16. Many computers in school	72	66	4	7	2	3
17. New things on computer	74	69	3	4	1	2
18. Being taught by a computer	58	62	18	11	1	2
19. Very short time on a computer	3	9	18	11	57	56
20. Computer to do all school work	61	63	14	6	3	7

Table 9.
Attitude to Computer - Division II
Comparison of the Project(P) and the Control(C) School
(Numbers given in columns are actual numbers of students)
* statistical significance (.05 level) using a Chi square test

For division II, the two items (item 15 is significant at the .06 level) showing differences focus on making errors, indicating that in both computer and pencil and paper tasks the project students do not like making mistakes. Otherwise there are no patterns in the data. This is somewhat surprising in that the grade 5 and 6 classes in the project group had not only exposure through

the Classroom Practice Mode but also through weekly computer literacy classes while the control group had very little exposure to computers.

The reaction of the project group to making mistakes could be a direct effect of the computer (drill) programs requiring absolute accuracy. In normal classroom work mistakes are often only detected the next day. Most teachers would welcome this change in attitude to making mistakes which should show up as work being done more carefully. However, if this attitude develops into a fear of making mistakes it could, in fact, hamper the learning process.

Knowledge of Computers

The Computer Questionaire instrument was administered in both the project and control schools in June. Below are given the responses to each item. At division I, only the Grade 2 scores are available and reported. Key phrases are identified in this table. For the complete instrument see Appendix B.

	Yes		Don't Know		No	
	P	C	P	C	P	C
*1. Parents use computers	15	10	52	74	33	16
*2. Disk drive	85	10	15	84	0	6
3. Make a computer	15	18	52	53	33	29
4. Electronic games vs computers	26	24	30	37	44	39
*5. Sad and happy	11	12	7	29	82	60
*6. Computers getting tired	15	31	18	26	67	43
7. Long addition	70	74	26	24	4	2
8. Nice to people	7	6	7	22	85	72
**9. Make up their own games	7	24	4	28	89	49
10. Afraid	0	0	0	4	100	96
*11. Wrong words	4	2	7	26	89	73
12. Take over the world	4	6	4	10	93	84
13. People vs computers	74	61	11	24	15	16
*14. Everybody	70	55	11	20	19	26
15. Would you use it?	100	94	0	4	0	2

Table 10.
Computer Knowledge - Grade 2
Comparison of the Project(P) and Control(C) School
(Numbers given in columns are percentages)
* indicates large differences
** statistical significance (.05 level) using a Chi square test

The seven items which show large differences are especially interesting because they show the project group in Grade 2 more knowledgeable in the areas of computers in society (1, 14), computer functioning (2,11), the computer's lack of emotions (5, 6), and man's control over computers (9). In every item (except one, 7) the project class showed superior knowledge about computers over the control group. Again these differences are to be expected because the project group had much more exposure to computers.

	Yes		Don't Know		No	
	P	C	P	C	P	C
*1. Parents use computers	1	9	16	27	61	40
*2. Disk drive	48	53	9	18	22	5
3. Make a computer	5	10	35	27	39	39
*4. Electronic games vs computers	9	20	12	19	58	39
*5. Sad and happy	1	8	6	8	70	60
*6. Computers getting tired	0	10	13	8	66	57
7. Long addition	62	54	7	11	10	10
*8. Nice to people	2	13	2	7	75	55
*9. Make up their own games	2	14	6	8	71	53
10. Afraid	0	5	1	2	78	68
11. Wrong words	2	6	4	6	72	64
12. Take over the world	17	20	27	17	34	38
13. People vs computers	69	59	5	6	4	11
14. Everybody	58	61	13	8	7	7
*15. Would you use it?	75	73	3	0	0	3

Table 11.
Computer Knowledge - Division II
Comparison of the Project(P) aand Control(C) School
(Numbers given in columns are actual numbers of students)
* statistical significance (.05 level) using a Chi square test

The seven of the eight items which show large differences indicate the project classes in division II to be more knowledgeable than the control classes. As in division I the items focus on computers in society (1, 15), the computer's lack of emotion (5, 6, 8), and man's control over computers (9) plus an item indicating differences between computers and video games. The eighth item shows fewer students in the project class thinking the disk drive is used to store information. Technically they are correct. It is the "diskette" which stores the information. Perhaps also they are thinking of the disk drive as a device for retrieving programs they wish to use. All the remaining items, although differences are not large, indicate the

project group is more knowledgeable, except one. The project group is less certain than the control that everyone needs to know something about computers. In any case the difference is very small. It is safe to conclude that the project group over-all is more knowledgeable about computers than the control group.

Longitudinal Patterns in Achievement

Analysis of the past four years' performances in mathematics and in reading comprehension was completed for all grades in only the project school. An examination of these year-end scores will show how the project classes compared to the classes in the same grade in previous years. Although there is a lot of variability in classes from year to year, looking at the pattern across four years should indicate generally how the project classes achieved. Analysis for the mathematics comparisons was complicated somewhat by a change in the mathematics curriculum and the subsequent mathematics survey test in the last year. To overcome these difficulties and to assure some comparability in the test comparisons the original scores were transformed by converting to standard scores using the relevant system means and standard deviations. For ease in interpretation, these standard scores were reconverted to scores with a mean of 50 and a standard deviation of 10. The reading comprehension analysis did not require such data transformations because the yearly scores were directly

comparable.

	Year			
	1980	1981	1982	1983
Grade 2 (Group Means)	48.9	48.5	49.8	52.7
Grade 3 (Group Means)	59.2	54.5	53.5	57.0
Grade 4 (Group Means)	55.1	56.4	48.2	50.1
Grade 5 (Group Means)	48.2	49.4	56.5	52.4
Grade 6 (Group Means)	54.2	49.5	51.4	54.0

Table 12.
EPSB Mathematics Survey Score Comparison for the Past Four Years

The pattern in grades 2, 3 and 6 is clear, showing a decline in 1981 and 1982 with an up-swing in scores for 1983. In grade 5, the 1983 score is higher than the 1980 and 1981 years but in grade 4, the 1983 score is higher only than the 1982 score. Interestingly the class that was in grade 3 in 1980 shows consistently the highest scores as they progress through the years. This "better" class tends to confound our search for consistent patterns. Finally we should note that although these scores have been standardized to a mean of 50, all the 1983 scores are above this mean. In general except for grade 4, the project classes seem to be slightly better than their counterparts in previous years.

	Year			
	1980	1981	1982	1983
Grade 2 (Group Means)	45.0	51.4	48.5	54.3
Grade 3 (Group Means)	63.8	58.3	59.7	61.6
Grade 4 (Group Means)	68.5	66.7	59.6	63.2
Grade 5 (Group Means)	61.4	69.0	72.1	62.6
Grade 6 (Group Means)	75.8	76.6	70.8	72.6

Table 13.
Reading Comprehension Mean Score Comparisons
for the Past Four Years

Our examination of the pattern of mean achievement in reading comprehension over the four years at each grade level indicates that only in grade five is the 1983 score lower than the two previous years. In fact, the patterns for grade 2, 3, and 4 are very clear in establishing 1983 as a year of recovery. The grade six score indicates a less significant recovery but the trend is there. So in 4 out of the 5 grades, language arts achievement scores did not suffer because of the focus on mathematics in the classrooms through the Classroom Practice Mode.

The Classroom Practice Mode--Conclusions and Recommendations

Benefit to students

The benefits to students were measured in four areas:

1) achievement

2) attitude to mathematics

3) attitude to computers

4) knowledge of computers

The area least affected by the Classroom Practice Mode is the attitude to mathematics. At division I (grades 2 and 3), the initial high attitude in December falls off for the computer classes by June. At division II, attitude does not appear to have been affected at all. For grades 3 and 4 the control school has a slightly better attitude to mathematics in June. Although better attitudes to mathematics might have been expected through using the computers, the extra time and emphasis on mathematics in the Classroom Practice Mode might lead to the opposite effect, namely boredom. The lack of any effect in division II may mean that these two effects nullified each other.

Only in division I did the project group have a better attitude toward computers than the control group. No differences in attitude to computers were found at division II. This shows, however, that the continual drill on computers for the year did not negatively effect the project group's attitude toward computers. It also shows that exposure to computers does not by itself mean an improved attitude toward them. In the Classroom Practice Mode the

computer was, in fact, a rather strict, unyielding task master, not fun and games. This latter fact may account for the negative reaction of the project group to making mistakes both on the computer and in pencil and paper work. Unfortunately the study does not give any indication as to whether or not this is a healthy dislike of making errors or an exaggerated, unproductive fear.

Not surprisingly, the project group showed they had a better understanding of computers, how they worked and their relationship to man and society.

Finally, achievement seems to have been positively affected by the Classroom Practice Mode. For each of three grades, the difference in total scores is almost 10 points which accounts for 20% of the total score. At grade six there was some initial difference which increased during the year. For grade two, a difference in December in favour of the control was wiped out by June. Only for grade 4 did the difference favour the control group - a difference of 5 points (about 10% of the total score.) The longitudinal analysis also indicates that except for grade 4 the 1983 scores are slightly higher than the average of the previous three years.

Several conclusions can be drawn from this data.

1. Achievement of mathematics is positively affected by the Classroom Practice Mode.

2. Attitude to mathematics is not affected by the Classroom Practice Mode.

3. Attitude to computers is affected in a limited but, in general, positive manner for the lower grades but not at all at division II.

4. Knowledge of computers is enhanced somewhat by exposure to the Classroom Practice Mode.

5. An interesting side effect of the Classroom Practice Mode is an increased dislike of making mistakes.

The Operation of the Classroom Practice Mode

As was conjectured initially teachers can operate in the Classroom Practice Mode of computer usage with little knowledge of computer operation. If teachers are given a free hand, they will adapt the Mode to their style of teaching. Three styles of usage emerged in the study:

1. Type A - Parallel Practice Pattern
2. Type B - Daily Practice Pattern
3. Type C - Spiral Practice Pattern

The style of usage was largely a function of teaching style but was influenced by how well the mathematics content of the drill (computer) program matched the curriculum at the different grades. Whatever the style, the computer usage did not constitute a major disruption to the normally busy elementary school classroom. Teachers seldom found it necessary to stop the computer and students had no trouble regaining their place in the lesson. Also the longitudinal analysis of language arts data indicates that language arts achievement did not suffer. This latter was a point of concern since the computer was being used in the classroom

Practice Mode even during language arts periods.

With only one computer in the classroom for one-half day every day, students' time on the computer amounted to 10% of their total mathematics program. The Classroom Practice Mode, regardless of the type of usage, can function with one basic computer-managed drill package supplemented by five or six other programs. Schools, then, do not need an extensive library of programs to run the Classroom Practice Mode. Of course, this usage is open-ended. Some teachers used 12 programs. Others found language arts programs to be very effective and would have used them more had the terms of the project allowed them.

All teachers, while somewhat hesitant about claiming achievement benefits, were confident of motivation benefits. Although some teachers had to put special effort into keeping motivation high, students continued to enjoy the new technology, even over the full school year.

The Classroom Practice Mode did not seem to solve the problem of the wide range of achievement in the classroom. In fact, if anything the computer spread students out farther. The teachers became concerned especially with slow workers who fell behind even in their computer work. Some teachers allowed slow workers more time on the computer. For the most part, however, teachers gave equal computer access to every student.

Of course, the effectiveness of the Classroom Practice

Mode is a function of the software available. The Math Sequences-Milliken program served effectively as a basic program of management. Teachers used it as much or as little as they pleased but they all fell back on it from time to time. Indeed the Milliken program, in general, served a very useful purpose. Some teachers felt it necessary to supplement it with faster paced programs or programs that had broader curriculum content.

The Classroom Practice Mode proved to be manageable by teachers with little background in computers. The majority of the teachers still know very little about operating a computer. The school-based consultant's time was devoted entirely to keeping the project moving. More consultant time is necessary to perform a genuinely educative function of giving teachers a broader knowledge of computers. The Classroom Practice Mode is a usage that can be adapted to various teaching styles and has an open-ended format which would allow teachers to explore computer applications other than drill. However, to go beyond the Classroom Practice Mode teachers will need a lot of support either through consultants or other inservices. The evidence from this study suggests that teachers in the elementary school have neither the resources, time nor energy to do this on their own.

Recommendations

The Classroom Practice Mode in mathematics would seem to be a suitable usage for a microcomputer in any elementary classroom. Initially teachers need support. As they become more familiar with this Mode of usage and the available software, they should be encouraged to expand their offerings. In addition to mathematics practice, language arts practice could receive some attention. Teachers should not be overly optimistic about the effect of the usage but should conceive of it as a starting point. Given this start, they can go on to possibly more important contributions of the computer.

Further Research

1. Although one computer used for drill purposes produces positive effects, two or three computers could become a classroom disruption. Studies examining the optimum number for the classroom should be initiated.

2. Teachers often mentioned that having a computer in the classroom all the time would increase the flexibility of usage. Cost effective studies could determine the feasibility of such an arrangement.

3. Three patterns of usage arose in this study. Investigations should be undertaken to determine if any of these is ultimately most suitable.

4. Within the project school debate arose over whether computer literacy and programming concerns should take precedent over the practice concerns of the Classroom Practice Mode. This debate will not be resolved by experimentation but by educators and parents deciding which "goals" are the more valuable. This issue deserves to be studied in the context of the elementary school.

5. As computers are more available in schools, studies of this nature should be replicated, especially with a view to establishing the apparent achievement gains and possibly to studying the side effect of students becoming very conscious of making errors.

6. Finally, this study begs the fundamental question: With computers available to do our computations is the increased emphasis on computational drill really justified? Simply having the technology to increase computational skills, does not make this an appropriate goal.

Appendix A

Computer programs that were available to teachers using the Classroom Practice Mode in:

1. Mathematics
2. Language Arts

Mathematics

1. Advanced Learning Technology
   A. Montown

2. Apple Computer Inc.
   A. Elementary My Dear Apple -Darts

3. Apple Computer Inc. The Shell Games (numeration and estimation exercises prepared by Avonmore School).

4. Avonmore School -Temperature

5. Developmental Learning Materials
   A. Alien Addition
   B. Minus Mission
   C. Meteor Multiplication
   D. Demolition Division
   E. Alligator Mix

6. Hartley Courseware Inc. -Clock

7. Houghton Mifflin
   A. Math Activities Courseware, Grade 6 (3 disks)

8. Lund, Charles
   A. Geometry and Measurement
      -Drill and Practice
      -Area and Perimeter

9. Minnesota Educational Computing Consortium
   A. Elementary Volume I
      -Hurkle
      -Speed Drill
      -Metric Estimation
      -Metric Measurement
      -Metric 21

10. Milliken Math Sequences
    A. Addition
    B. Subtraction
    C. Multiplication
    D. Division
    E. Decimals
    F. Fractions
    G. Percent

11. San Juan Unified School District
    -Boxes
    -Speed Drill

Language Arts

1. Data Command
   - A. Tank Tactics (basewords)
   - B. Pit Pet Put (contractions)
   - C. Tennis Anyone (plurals)
   - D. Riddle Me This

2. Edu-Ware Services Inc.
   - A. Compu Read

3. Hartley
   - A. Multiple Skills
   - B. Vowels

4. Minnesota Educational Computing Consortium
   - A. Prefixes
   - B. Spelling
   - C. Utilities - creates crosswords, word find
   - D. Phonet
   - E. Sims - word games

5. Milliken
   - A. Reading Comprehension
   - B. Homonyms
   - C. Pronouns
   - D. Verbs
   - E. Alphabetizing

Appendix B

Instruments Used

1. Computer Questionaire
2. Survey of Computer Attitudes
3. Survey of Mathematics Attitude - Division I
4. Survey of Mathematics Attitude - Division II

NAME _____

SCHOOL _____

GRADE _____

COMPUTER QUESTIONNAIRE

June 1983

COMPUTER QUESTIONS

1. Did your parents learn mathematics using computers?

   Yes ☐
   I don't know ☐
   No ☐

2. Is a disk drive used to store information for a computer?

   Yes ☐
   I don't know ☐
   No ☐

3. Could you make a computer by wiring a typewriter to a television set?

   Yes ☐
   I don't know ☐
   No ☐

4. Do electronic game machines do exactly the same things as computers?

   Yes ☐
   I don't know ☐
   No ☐

5. Can computers be sad one day and happy the next day?

   Yes ☐
   I don't know ☐
   No ☐

6. Do you think that computers get tired of doing the same thing over and over again?

Yes ☐
I don't know ☐
No ☐

7. Do you think that computers can do long addition problems better than people?

Yes ☐
I don't know ☐
No ☐

8. Can computers be nice to people one day and be mean the next day?

Yes ☐
I don't know ☐
No ☐

9. Do you think that computers can make up their own games or programs?

Yes ☐
I don't know ☐
No ☐

10. Should people be afraid of computers?

Yes ☐
I don't know ☐
No ☐

11. Would a computer break if you typed in the wrong words?

Yes ☐
I don't know ☐
No ☐

12. Do you think that computers could take over the world?

Yes ☐
I don't know ☐
No ☐

13. Do you think that people can do things that computers can't do?

Yes ☐
I don't know ☐
No ☐

14. Do you think that everybody should know something about computers?

Yes ☐
I don't know ☐
No ☐

15. If somebody gave you a computer, would you use it?

Yes ☐
I don't know ☐
No ☐

NAME _____

SCHOOL _____

GRADE _____

SURVEY OF COMPUTER ATTITUDES

June 1983

COMPUTER SURVEY

1. Working with a computer.	2. Doing addition problems on a computer.
3. Playing games on a computer.	4. Doing addition problems with pencil and paper.
5. Doing subtraction problems on a computer.	6. Having a long time to work on a computer.
7. Being able to practice my mathematics skills on a computer.	8. Making pictures with a computer.
9. Getting the wrong answers when a computer asks a question.	10. Sharing a computer with other people.

11. Answering mathematics questions on a computer.	12. Answering a computer's questions.
13. Getting the right answer to a computer's question.	14. Trying to figure out how a computer works.
15. Making mistakes when working with pencil and paper.	16. Having many computers in my school.
17. Trying out new things on a computer.	18. Being taught by a computer.
19. Having a very short time to work on a computer.	20. Having my own computer to do all school work.

NAME _____

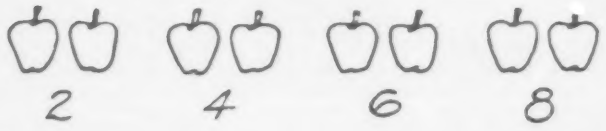
SCHOOL _____

GRADE _____

SURVEY OF MATHEMATICS ATTITUDE

DIVISION I

1.



2.

2 + 1 =

10 + 9 =

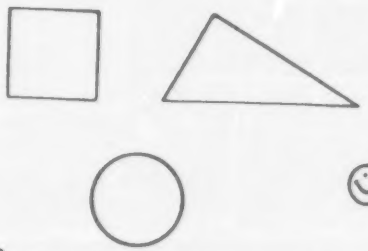
3.

1 = one

10 = ten

100 = one hundred

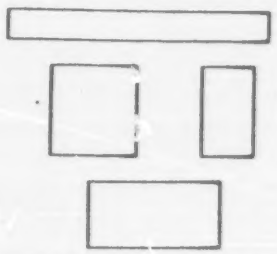
4.



5.

$$\begin{array}{r} 3 \\ -\,1 \\ \hline \end{array} \qquad \begin{array}{r} 10 \\ -\,2 \\ \hline \end{array}$$

6.



7.

8.

32 19

15 26

9.

10 − ☐ = 3

☐ = ?

10.

2 ___ 4

99 ___ 101

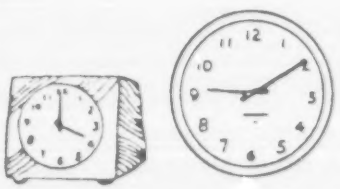
11.

TEN

↓

9 7 10 27

12.



88

5 10 ?

13.

49 = 40 + 9

14.

29 30 ? 32 33

15.

14
- 8
6

16.

5 + 3 = 3 + 5

17.

Mary has 3 marbles. Bill gave her 4 more. How many marbles does Mary have now?

18.

o o o o o o o o o o
o o o o o o o o o o o o o = 23

19.

First Second Third Fourth

20.

PART 2

In this part some sentences about mathematics will be read to you. Fill in the face that best describes how you feel about the sentence.

Counting sets of things.

21.

Finding a number that comes between 27 and

89

22.

Writing eighty-five as 85.

23.

Solving problems in mathematics.

24.

Seeing why 4 + 8 is the same as 8 + 4.

25.

Finding boundaries and corners of figures in geometry.

26.

Folding figures in geometry.

27.

Doing addition problems.

28.

Finding triangles, circles, and squares in geometry.

29.

Doing subtraction problems.

30.

PART III

In this part, some words will be read to you about mathematics. Fill in the faces that best describes how you feel about these words.

Counting.

31.

Adding.

32.

Computers.

33.

Subtracting.

34.

Geometry.

35.

NAME _____

SCHOOL _____

GRADE _____

SURVEY OF MATHEMATICS ATTITUDE

DIVISION II

December, 1982

Learning what numbers mean

1,000 = one thousand
1,000,000 = one million

LIKE
Not Sure or Don't Care
DISLIKE

1.

Adding numbers

$$\begin{array}{r} 29 \\ +\ 17 \\ \hline \end{array}$$

LIKE
Not Sure or Don't Care
DISLIKE

2.

Telling which number comes next in the series

12 15 18 ?

LIKE
Not Sure or Don't Care
DISLIKE

3.

Multiplying big numbers

$$\begin{array}{r} 69753 \\ \times\ 726 \\ \hline \end{array}$$

LIKE
Not Sure or Don't Care
DISLIKE

4.

Finding the missing number

$\square + 132 = 136$

$\square = ?$

LIKE
Not Sure or Don't Care
DISLIKE

5.

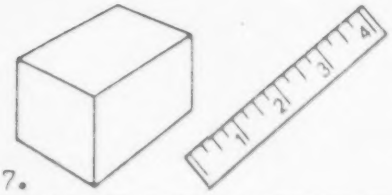
Doing hard subtraction problems

$$\begin{array}{r} 72145 \\ -\ 9897 \\ \hline \end{array}$$

LIKE
Not Sure or Don't Care
DISLIKE

6.

Measuring things



LIKE
Not Sure or Don't Care
DISLIKE

7.

Dividing numbers

$16 \div 4 =$

LIKE
Not Sure or Don't Care
DISLIKE

8.

Solving word problems

A new basketball cost $4.50 plus 5% sales tax. How much does the basketball cost *including* tax?

LIKE
Not Sure or Don't Care
DISLIKE

9.

Learning about fractions

$\frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$

LIKE
Not Sure or Don't Care
DISLIKE

10.

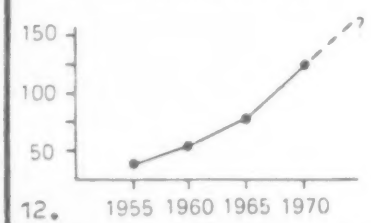
Multiplying numbers in different ways

$15 \times 3 = (10 + 5) \times 3$
$= (10 \times 3) + (5 \times 3)$

LIKE
Not Sure or Don't Care
DISLIKE

11.

Learning how to use charts



LIKE
Not Sure or Don't Care
DISLIKE

12.

Written numbers and numerals.

1 = one

10 = ten

100 = one hundred

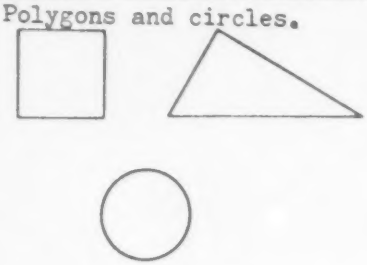
LIKE

Not Sure or Don't Care

DISLIKE

13.

Polygons and circles.



LIKE

Not Sure or Don't Care

DISLIKE

14.

Finding missing numbers.

$10 - \square = 3$

$\square = ?$

LIKE

Not Sure or Don't Care

DISLIKE

15.

Betweenness.

2 ___ 4

99 ___ 101

LIKE

Not Sure or Don't Care

DISLIKE

16.

Numbers in numeral or written form.

TEN

9 7 10 27

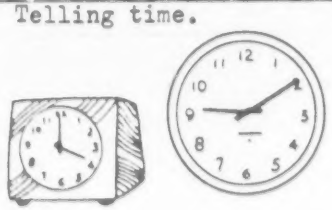
LIKE

Not Sure or Don't Care

DISLIKE

17.

Telling time.



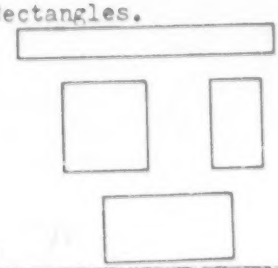
LIKE

Not Sure or Don't Care

DISLIKE

18.

Rectangles.



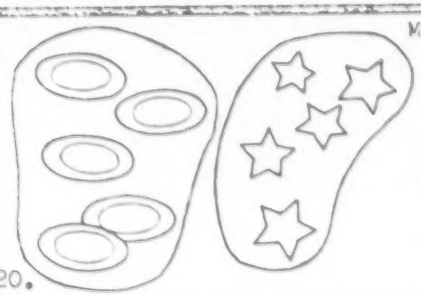
LIKE

Not Sure or Don't Care

DISLIKE

19.

Matching sets.



LIKE

Not Sure or Don't Care

DISLIKE

20.

Adding numbers.

LIKE

Not Sure or Don't Care

DISLIKE

21.

Using computers.

LIKE

Not Sure or Don't Care

DISLIKE

22.

Subtracting numbers.

LIKE

Not Sure or Don't Care

DISLIKE

23.

Working with geometric polygons.

LIKE

Not Sure or Don't Care

DISLIKE

24.

PART 2

In this part some statements will be made about mathematics. You are to put an X before the statement that best describes how you feel about the statement.

25. I enjoy trying to solve new problems in mathematics.

____ Yes, I agree.
____ Undecided.
____ No, I disagree.

26. I would like to increase my skills in mathematics.

____ Yes, I agree.
____ Undecided.
____ No, I disagree.

27. I like mathematics because there is always a correct answer.

____ Yes, I agree.
____ Undecided.
____ No, I disagree.

28. Mathematics makes me feel uncomfortable.

____ Yes, I agree.
____ Undecided.
____ No, I disagree.

29. I enjoy using mathematics outside school.

____ Yes, I agree.
____ Undecided.
____ No, I disagree.

30. I am afraid of doing word problems.

____ Yes, I agree.
____ Undecided.
____ No, I disagree.

31. In your own opinion, how good do you think your work is in mathematics?

____ Among the best.

____ Average.

____ Among the poorest.

32. Where do you think you would rank in your class in mathematics?

____ Among the best.

____ Average.

____ Among the poorest.

33. How important to you are the grades that you get in mathematics?

____ They are important.

____ They are no more important than other grades.

____ They are not important.

34. What statement best describes your feelings about mathematics?

____ I like to get better grades than other people.

____ I like to get about the same grade as everyone else.

____ I don't care what grade I get.

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